Teton River Subbasin Assessment
And
Total Maximum Daily Load

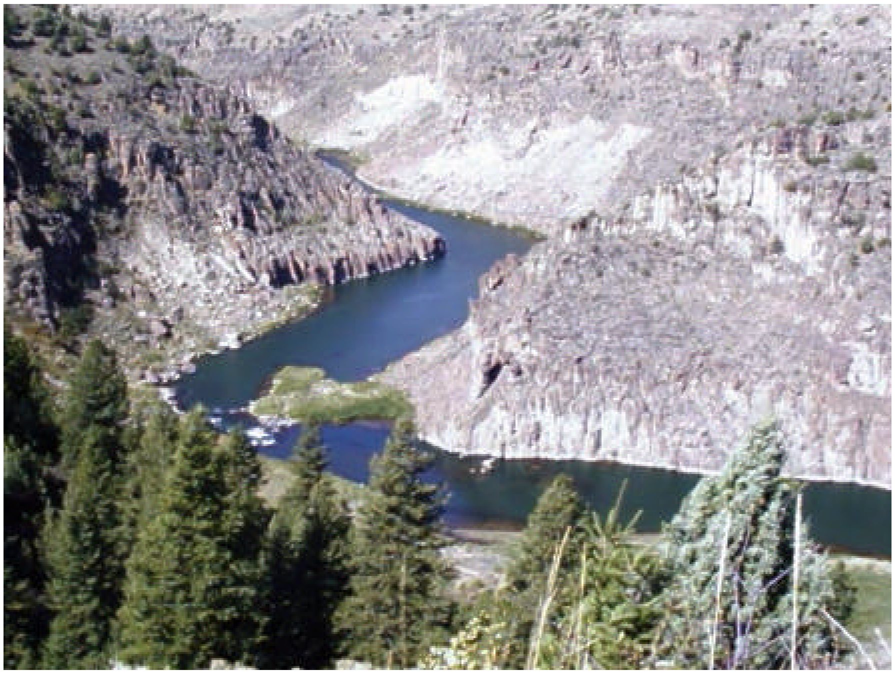

Photo courtesy of Timothy Randle, Bureau of Reclamation

Department of Environmental Quality

January 10, 2003

ANALYSIS OF WATER QUALITY DATA FOR §303(D)-LISTED SEGMENTS

Badger Creek

The Badger Creek subwatershed covers an area of approximately 60 square miles or 37,587 acres. About 40% of the subwatershed is in Wyoming, and this portion is located entirely within the boundaries of the Caribou-Targhee National Forest. The remaining portion of the subwatershed, which is located in Idaho, consists of approximately 80% privately owned agricultural land and 20% public lands managed by the Caribou-Targhee National Forest, Idaho Department of Lands, BLM, or BOR.

The elevation of Badger Creek drops by half as it flows from headwaters in the Jedediah Smith Wilderness Area to its confluence with the Teton River. The South Fork of Badger Creek originates at an elevation of more than 9,000 feet, less than one-quarter mile west of the border of Grand Teton National Park. Approximately 3.5 miles west of the Idaho-Wyoming border, at an elevation of about 6,300 feet, the South Fork converges with the North Fork to form the mainstem of Badger Creek. Badger Creek continues to drop in elevation, though much more gradually as it flows in a west-northwesterly direction through rolling, gently sloping soils. Bull Elk Creek, a major tributary, enters Badger Creek at an elevation of 5,900 feet, just upstream of the point at which Badger Creek drops into a narrow canyon. Over its final 3 to 4 miles, Badger Creek drops almost 600 feet in elevation, and enters the Teton River at an elevation of approximately 5,300 feet.

Land use in the Badger Creek subwatershed was described by the TSCD (1991) as follows: approximately 68% rangeland and forest (25,374 acres); 20% non-irrigated cropland (7,466 acres); 12% irrigated cropland (4,537 acres); and less than 1% urban and farmstead development, pasture, and water. Based on the distribution of acres among treatment units, approximately 19% of the cropland had an average erosion rate of less than 10 tons/acre/year, 55% had an average erosion rate of 10 to 20 tons/acre/year, and 26% had an average erosion rate of 20 to 24 tons/acre/year.

§303 (d)-Listed Segment Approximately 5 miles of Badger Creek appeared on the 1996 §303(d) list, and sediment was listed as the pollutant of concern (Figure 22). The upper boundary of this segment was described as R45E T6N S10, which is a range, township and section location; the lower boundary was described as the first tributary, which has been interpreted as Bull Elk Creek (Figure 22). The basis for selecting the upper boundary was not documented, but approximately 0.5 mile below the western boundary of section 10, the USGS 7.5-minute map of the Tetonia Quadrangle shows that flow in Badger Creek changes from perennial to intermittent. It is possible that the upper boundary was intended to correspond to this location (NW1/4, SW1/4, S9, R45E, T6N). The segment of Badger Creek described in the 1996 §303(d) list extends from its upper boundary approximately 2.5 miles west-northwest toward the town of Felt and Highway 32, and ends approximately 2.5 miles northwest of Felt. In 1995, BURP samples were collected in the vicinity of the upper boundary of the segment, at the approximate midpoint of the segment, and at a location approximately one stream mile below the lower boundary of the segment (Figures 23-25).

The results of BURP sampling and assessment indicated that the beneficial use of cold water aquatic life was supported within the segment listed, but was not supported below the segment. The MBI score at the upstream sampling site (4.05) indicated full support of cold water aquatic life. The MBI score at the middle sampling location (2.52) indicated that support of cold water aquatic life needed verification, but the assessment was upgraded to full support because the HI score (104) indicated full support. The MBI score at the downstream site (1.24) indicated that the beneficial use of cold water aquatic life was not supported. Based on these BURP results, the boundaries of the listed segment of Badger Creek were revised on the 1998 § 303(d) list. The upper boundary was moved 1.5 miles downstream to Highway 32 and the lower boundary was moved approximately four miles downstream to the confluence of Badger Creek with the Teton River.

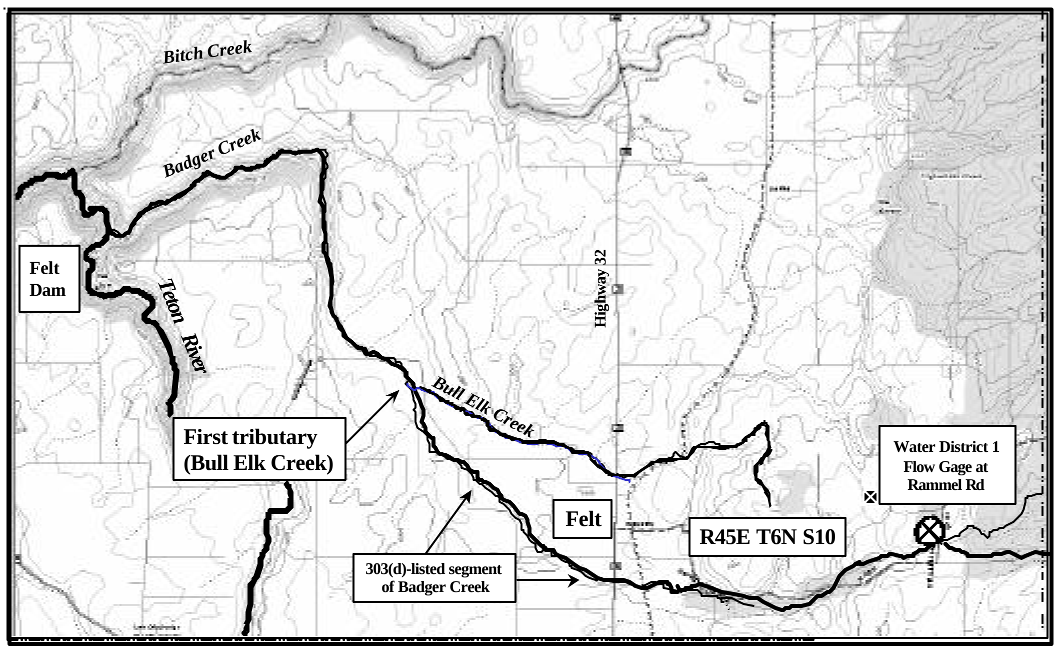

Figure 22. Boundaries of the segment of Badger Creek identified on Idaho's 1996 section 303(d) list. Pollutant of concern was sediment.

Flow Surface water flows in the Badger Creek subwatershed follow the pattern previously described for drainages at the base of the Teton Range. Most streams are intermittent, flows are primarily determined by winter snowpack, and springs are important contributors to surface water flow, especially in lower Badger Creek. According to USGS 7.5-minute maps, the only stream segments within the Badger Creek subwatershed that flow perennially are South Badger Creek from its headwaters to its confluence with the North Fork of Badger Creek and Badger Creek from the confluence of the North and South Forks to a point downstream approximately two miles. Although Bull Elk Creek is a major tributary of Badger Creek, its flow is intermittent.

Water District 1 measures flow in Badger Creek at Rammel Mountain Road, immediately downstream of the confluence of the North and South Forks. Flows are determined using a current meter or by comparing staff gage heights to an index. Measurements of flow are recorded on an irregular basis throughout the irrigation season, generally from May or June through September or August, and have not been recorded for the winter months from December through March. Flows are also measured at five other locations in the Badger Creek subwatershed, but these measurements are for water diverted from Badger Creek and are not necessarily indicative of instream flows. The flows measured in Badger Creek at Rammel Mountain Road from 1980 through 1998 are summarized in Figure 26. Because flows may change substantially from the beginning to the end of each month, the data shown in the figure are averages of measurements taken during 3-, 10- or 11-day periods.

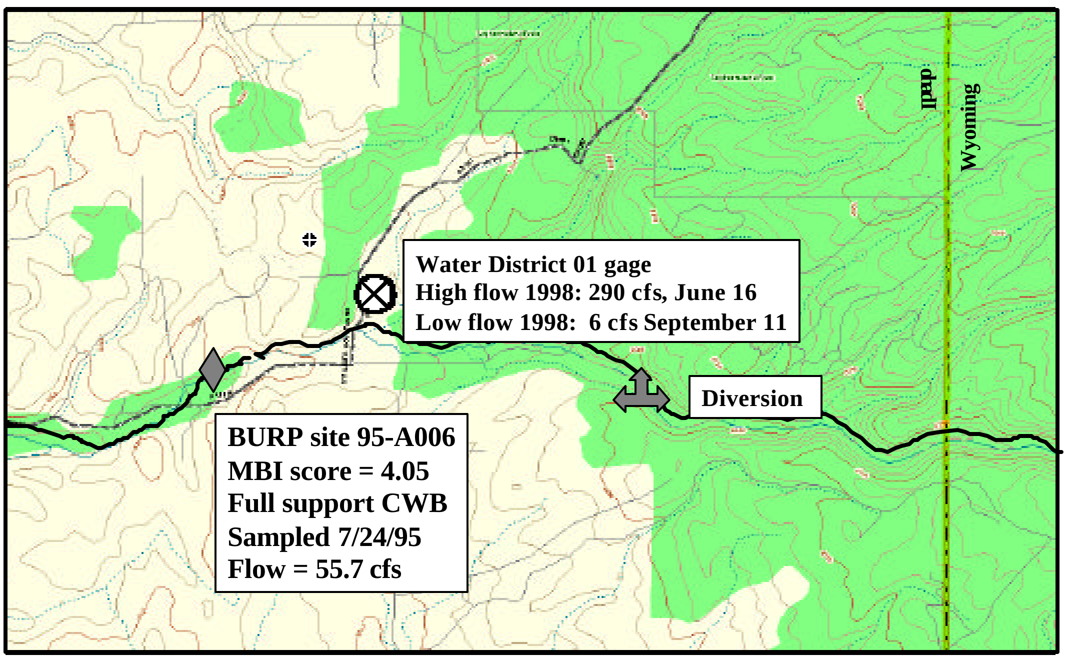

Figure 23. Data collection sites on upper Badger Creek.

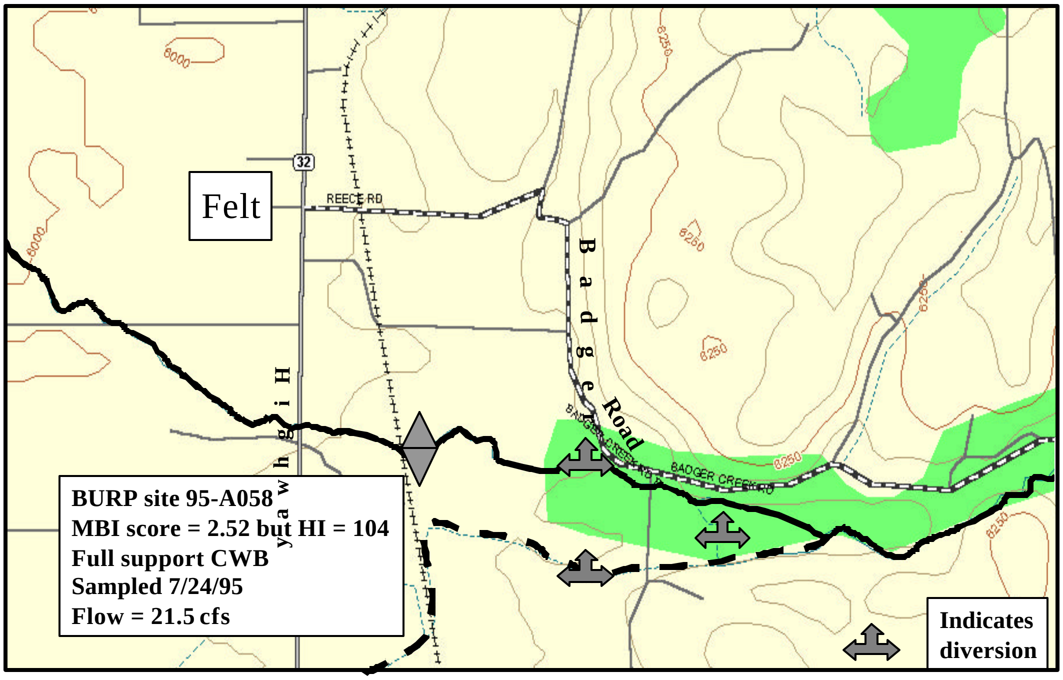

Figure 24. Data collection sites and locations of major diversions on middle Badger Creek near Felt.

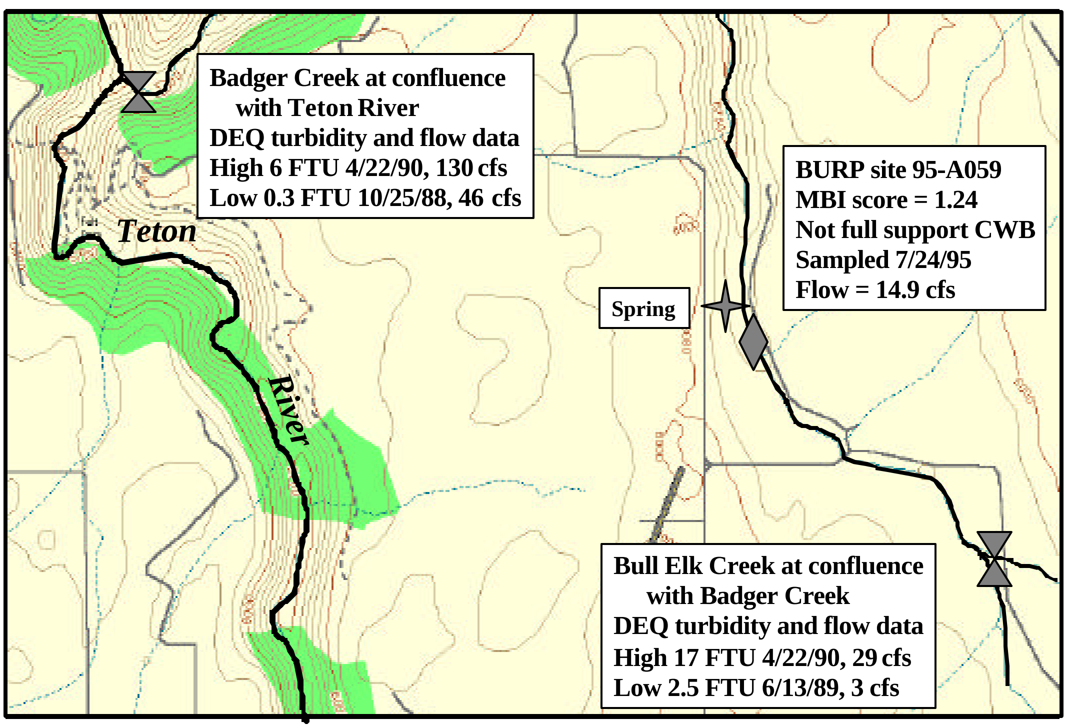

Figure 25. Data collection sites on lower Badger Creek and Bull Elk Creek

Flow records from 1980 through 1998 indicate that 1) maximum or peak flows occur in May or June, with average monthly flows of 180 cfs in May, 164 cfs in June, 46 cfs in July, and 10 cfs in August; 2) maximum flows may vary as much as an order of magnitude among years, as indicated by the records for June 1983 (425 cfs) and June 1994 (45 cfs); 3) flows typically decline to less than 10 cfs by mid-August, and continue to decline through October; and 4) water may be diverted from Badger Creek for irrigation from the beginning of May through August, though the greatest demand for water is in June and July (Carlson 1980-1998).

Average flows ranged from 106 to 208 cfs for the 10-day periods in May and June, from 25 to 67 cfs for the 10-day periods in July, from 6 to 9 cfs for the ten-day periods in August, and from 3 to 7 cfs for the 10-day periods in September and October. As shown in Figure 26, average flows increase rapidly in early May, remain relatively high until late June, and decline steadily through July and August. The lowest flow measured was 0.5 cfs in October 1989 and September 1990.

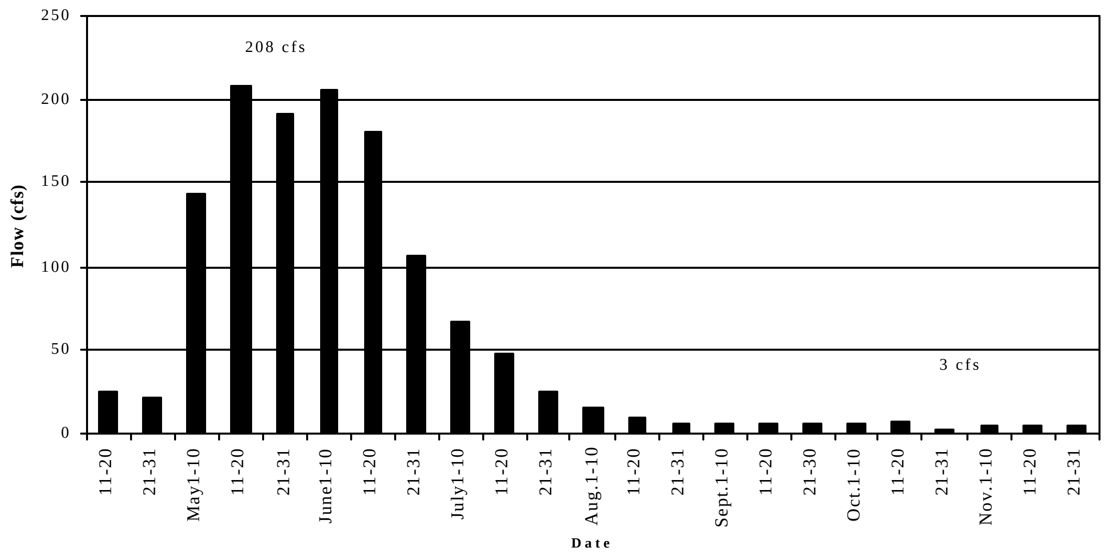

Figure 26. Eighteen-year average flows measured on Badger Creek at Rammel road.

Although flow records indicate that water usually persists in Badger Creek at Rammel Road even in October, local residents and the NRCS District Conservationist report that Badger Creek downstream of Rammel Road is typically dry from mid-August through April because the small amount of water that remains in the channel at base flow infiltrates into the porous soils of the stream channel. Just upstream of Rammel Road, the soils are Badgerton loams, which are excessively drained and have low water capacity. The Wiggleton loams predominate throughout the middle segment of Badger Creek. In the vicinity of the confluence of Bull Elk Creek, the Wiggleton loams are replaced by Rammel and Judkins series soils that, while permeable, are underlain by bedrock at a depth of 20 to 40 inches (USDA 1969). Local residents also report that there is typically no flow in Badger Creek throughout the summer from the area in which water is diverted (Figure 23) to a location downstream of the confluence of Bull Elk Creek where a spring restores instream flow (Figure 25).

The lack of flow in Badger Creek is supported by thermograph data collected by IDFG in 1996. Flows were average or above average in 1996, with the peak recorded flow of 335 cfs occurring in early June. A thermograph deployed on May 21 in Badger Creek below the confluence of Bull Elk Creek recorded water temperatures on an hourly basis until July 21, when the stream apparently became dry (Schrader 2000a). The flow measured at Rammel Road three days later on July 24 was 15 cfs, indicating that flows measured at Rammel Road are not representative of flows further downstream.

The Teton Canyon Water Quality Planning Project (TSCD 1991) identified 12,003 critical acres for treatment within the Badger/Bull Elk subwatershed. At the time the planning project was written, 161 acres were being treated and 11,842 acres remained to be treated. Critical acres were defined as “those cropland and non-cropland acres where the annual estimated soil erosion rate from sheet, rill, and gully and wind erosion exceeds the USDA estimated tolerable soil loss for a soil series” (TSCD 1991).

Water Quality Data In conjunction with the Teton Canyon Watershed Area planning study initiated by the TSCD in the late 1980s, DEQ attempted to collect bimonthly water quality data from October 1988 through May 1990 at three locations in the Badger Creek subwatershed: Badger Creek at the Caribou-Targhee National Forest boundary, Bull Elk Creek immediately above its confluence with Badger Creek, and Badger Creek immediately above its confluence with the Teton River. However, because of the absence of flow or inaccessibility of sampling sites, data were collected at all three locations on only six occasions beginning in April 1989 (Drewes 1993).

Because the water quality samples collected by DEQ were obtained during “continuing dry weather conditions,” the results were not considered indicative of “the true potential for agricultural impacts on water quality” (Drewes 1993). Within that context, the data support the following observations:

1. Excessive concentrations of sediment were not transported to the mouths of Badger or Bull Elk Creek during the period of study. The highest values for nonfilterable residue (36 mg/L at the forest boundary and 56 mg/L on Bull Elk Creek) were well below the target of 80 mg/L suspended solids; the highest value for turbidity (17 FTU on Bull Elk

Creek) was well below the target of 50 NTU. In making comparisons to targets, the assumption are that measurement of total nonfilterable residue will produce a result comparable to measurement of total suspended solids, and measurement of FTUs will produce a result comparable to measurement of NTUs.

2. The conductivities of samples collected from Badger Creek at the forest boundary were similar to conductivities of samples collected at the mouth of Bull Elk Creek, but were generally one-half to one-fourth the conductivities of samples collected at the confluence of Badger Creek with the Teton River. Because conductivity is an indicator of the concentration of dissolved solids (i.e., salts) in water, the differences in conductivities may have indicated that salts were accumulating in surface water from upland sources as the water flowed through the subwatershed. The differences in conductivities may also indicate that water at the mouth of Badger Creek originated from ground water instead of snowmelt.

3. Concentrations of NO_2 + NO_3 (nitrite plus nitrate), which is essentially a measure of NO_3 in surface water, were highest in water collected from the mouth of Badger Creek, again indicating that nitrogen was accumulating as water flowed through the subwatershed or that the water in the lower subwatershed was from a ground water source. Regardless of the source, the concentrations of nitrate in five of seven water samples collected from Badger Creek at its mouth exceeded the target of 0.3 mg/L (i.e., the concentration that may cause excessive plant growth in streams), averaging 0.52 mg/L. Nitrate concentrations in samples collected from Bull Elk Creek exceeded 0.3 mg/L in April 1989 and April 1990, and the average concentration of the remaining four samples was 0.22 mg/L. In contrast, the average concentration of nitrate in samples collected at the forest boundary was 0.04 mg/L.

4. Concentrations of total phosphorus twice exceeded the target of 0.1 mg/L in Bull Elk Creek, but were below the detection limit of 0.05 mg/L in all samples collected at the forest boundary and at the confluence of Badger Creek with the Teton River. Because total phosphorus generally measures undissolved phosphorus adsorbed to soil particles, these results indicate that soil and associated phosphorus were being transported in Bull Elk Creek, but not in Badger Creek. Furthermore, the contribution of phosphorus to Badger Creek by Bull Elk Creek was either diluted or did not reach lower Badger Creek. The absence of detectable total phosphorus in lower Badger Creek also indicates that the source of water in Badger Creek at this location was ground water.

5. Except in one instance, fecal coliform bacteria concentrations were far below the concentrations that would have violated Idaho’s water quality criteria for secondary contact recreational use (800 colonies/100 mL). It is difficult to interpret the significance of the extremely high concentration of fecal coliform in Bull Elk Creek in June 1989 (19,000 colonies/100 mL) because follow-up samples were not collected. When fecal coliform concentrations were measured throughout the Teton Subbasin by DEQ in 1999, the highest concentration measured was 663 colonies/100 mL, indicating that the value obtained in 1989 was anomalous.

Drewes (1993) described the Badger Creek subwatershed as the most "intensely" farmed of all subwatersheds in the Teton Canyon Watershed Area, and attributed the high concentrations of nitrogen to addition of nitrogen fertilizers. Although it is disputable that Badger Creek was more intensively farmed than other subwatersheds, the sources of elevated nitrogen were very likely grazing, growth of alfalfa hay, and/or application of nitrogen fertilizers. Cropland accounted for 32% of land use in the Badger Creek subwatershed, 42% in the Canyon Creek watershed, and 68% in the Milk Creek watershed (TSCD 1991).

The only continuous temperature data for Badger Creek was collected by IDFG in 1996 from May 21 to July 21, when the stream apparently became dry (Schrader 2000a). Temperatures did not exceed the water quality criteria for cold water aquatic life (i.e., less than 22°C instantaneous with a maximum daily average less than 19°C). Salmonid spawning criteria were exceeded from mid-June through July (Figure 27), but spawning does not occur at this time.

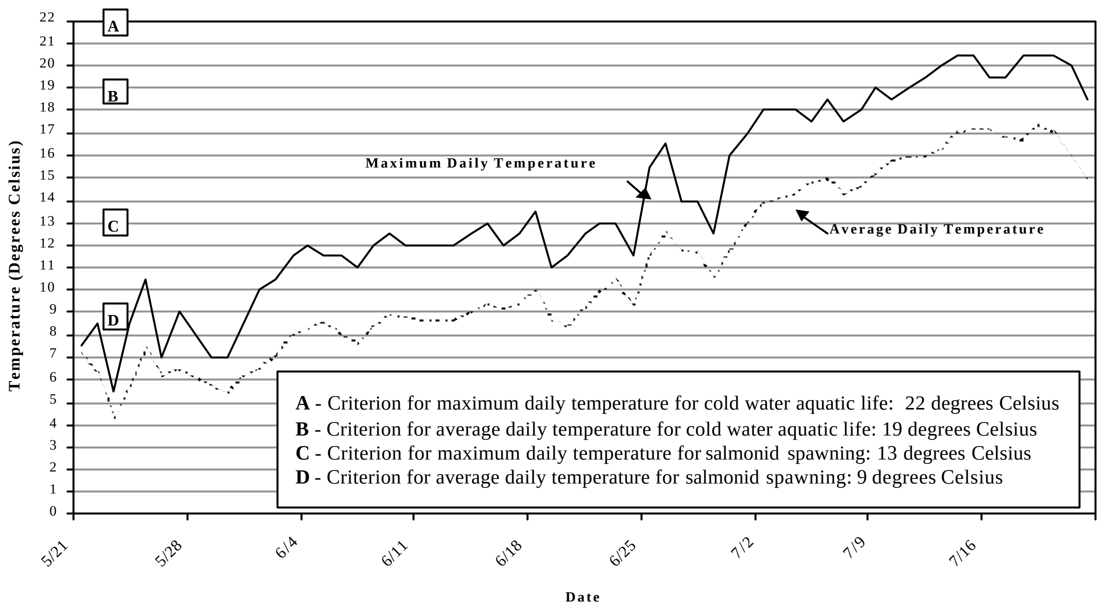

Figure 27. Water temperatures in Badger Creek from May 21 through July 22, 1996 (Schrader 2000).

Fisheries Recent fisheries information is available for Badger Creek, but only for portions that are upstream of the segment that appears on the 1998 §303(d) list. In August 1998, DEQ confirmed the presence of cutthroat trout in Badger Creek below Rammel Road by electrofishing BURP site 95-A006 (Figure 23). One pass was made through a 100-m reach, and two cutthroat trout (*Oncorhynchus clarki*), 100 to 119 mm in length, were captured. No other fish of any species were observed. In accordance with DEQ protocol, an effort was made to electrofish all BURP sites on Badger Creek. The absence of electrofishing data for the two downstream sites on Badger Creek indicates there was no flow at these sites on August 4, 1998 when the electrofishing occurred.

Fisheries data were also collected in 1998 by the Caribou-Targhee National Forest on South Badger Creek above the forest boundary. Techniques used to conduct the survey included electrofishing from the forest boundary to the wilderness boundary and snorkeling above the wilderness boundary. Cutthroat trout was the only fish species observed in 25 sampling sites spanning more than 7 miles of stream. The number of fish in size classes ranging from less than 50 mm to 250 mm indicate that the population is self-sustaining. According to notes made by the forest biologist, South Badger Creek had the highest occurrence of Yellowstone cutthroat trout of any of the streams sampled in 1998. A fish habitat survey was also conducted on South Badger Creek above the forest boundary in 1991 (Raleigh Consultants 1991). The section surveyed extended 9.4 miles from the forest boundary to a "small cascade and waterfall," and had an average gradient of 2.59%, average width of 4.7 m, and average depth of 0.2 m. The narrative report of the survey included the following observations of stream condition:

> ...Scattered log jams and beaver dams have caused water to overflow the banks in several places causing channel cutting. The upper section has several springs and some marshy ground that adds silt to the stream. ... [The stream] appeared to be in relatively good condition for a small, moderate gradient stream. There were sheep grazing in the lower section with little noticeable adverse affects to the stream, streambanks, or riparian area. The beaver dam areas and some log jams were causing minor bank cutting and side channels along the stream but it was not extensive or severe.

Regarding fisheries, the report stated:

> A sparse population of trout of all age classes (fry, juvenile, and adult) were seen throughout the reach. ... Two species of trout may be present in the stream. The observer reported brook trout and a species without a white leading edge on the pectoral fins...either cutthroat or rainbow trout.

Stocking records available from IDFG show that Badger Creek was stocked with more than 300,000 Kokanee (October spawner) fry in 1975; more than 100,000 cutthroat fry in 1976; and more than 11,000 rainbow/cutthroat hybrids in 1981 (http://www.state.id.us/fishgame/catalog1.htm). Despite stocking and the report of brook trout in 1991 (Raleigh 1991), no trout other than cutthroat were observed by either DEQ or the Forest Service in 1998.

The BLM, which manages less than a quarter section of land on North Badger Creek and half section of land at the mouth of Badger Creek, conducted site visits in 1994 to verify water rights and conduct stream health evaluations (Kotansky 1999). In 1997, BLM contracted with the Riparian and Wetland Research Program of the University of Montana to conduct a more thorough stream health evaluation on North Badger Creek. Data forms from 1994 indicate that flow in the North Fork of Badger Creek was 0.04 cfs on August 11, and flow in Badger Creek near the confluence with the Teton River was 38 cfs on August 24. The conductivity of water in the North Fork was 50 micro mhos per centimeter (ìmhos/cm); conductivity in Badger Creek near the confluence was 220 ìmhos/cm. There were no grazing or other impacts noted for either of the areas, and the riparian vegetation on the North Fork was described as excellent while the riparian vegetation on Badger near the confluence was naturally poor due to the steep walls of the canyon and large rocks lining the streambanks. The health inventory conducted on North Badger Creek in 1997 indicated that the streambank was well armored and the stream was healthy and in proper functioning condition, with scores of 98% “without Pfankuch” and 94% “with Pfankuch” (BLM data files). The tree and forb community was described as subalpine fir (*Abies lasiocarpa*) and claspleaf twistedstalk (*Streptopus amplexifolius*) with high regeneration of Douglas fir. This portion of the stream was not a source of sediment.

Discussion Because of the natural flow regime of Badger Creek, it is unlikely that the beneficial uses of cold water aquatic life and salmonid spawning can be supported year-round throughout the segment that appears on the 1998 §303(d) list. In the absence of multi-year flow data collected within this segment, this conclusion is supported by the observations of local residents, which are in turn supported by flow data collected at Rammel Road. These data indicate that flows were uncharacteristically high when BURP samples were collected in 1995. The peak flow occurred in 1995 on June 15, but based on the 18-year flow record, peak flows occur after June 10 only one year in three. Also, the flow measured at Rammel Road on July 27, three days after the DEQ BURP samples were collected, was 8 cfs higher than the 18-year average for late July.

In 1999, the Henry’s Fork Watershed Council Water Quality Subcommittee recommended that Badger Creek be divided into six segments for the purpose of designating beneficial uses for state water quality standards (Appendix D). The boundaries of the segments correspond with the Idaho-Wyoming state line, the locations of irrigation diversions, the confluence of the north and south forks of Badger Creek, and the location of a spring which significantly influences flow. One segment consists of the entire North Fork of Badger Creek. The South Fork of Badger Creek downstream of the state line is divided into two segments at the point at which water is diverted to the Haden Canal. The mainstem of Badger Creek is divided into three segments: 1) the confluence of the forks to a diversion spillway approximately 1 mile downstream, 2) the diversion spillway to a spring approximately 5 miles downstream and 1 mile below the confluence of Bull Elk Creek, and 3) the springs to the confluence with the Teton River. The segments recommended for the mainstem of Badger Creek are based on the presence or absence of instream flow volumes adequate to support beneficial uses. The upper and lower segments typically contain water; the middle segment typically does not. The recommendations of the Watershed Council are supported by information provided by local residents and resource managers and flow data collected by Water District 1. Additional BURP sampling by DEQ is required to adequately assess the status of beneficial uses in these segments.

Conclusions Conclusions regarding the water quality status of Badger Creek are listed below.

1. Available data do not link sediment to impaired beneficial uses in the segment of Badger Creek that appeared on the 1998 §303(d) list. In the absence of sufficient data to indicate that sediment is *not* a source impaired water quality, a TMDL for sediment is warranted based on the *Teton Canyon Water Quality Planning Project* prepared in 1991 by the Teton Soil Conservation District (TSCD 1991).

2. Discharge in the segment of Badger Creek that appeared on the 1998 §303(d) list is intermittent from Highway 32 to the springs downstream of the confluence of Bull Elk Creek. The biological indices used by DEQ to assess the beneficial uses of cold water aquatic life and salmonid spawning were developed using data collected for aquatic insect or fish communities sampled in perennially flowing reference streams. Similar species diversity and other community measures cannot be expected to occur in channels that periodically become dry. Therefore, it is not appropriate for DEQ to use data collected using the BURP protocol to assess beneficial use support in the mainstem of Badger Creek below Highway 32.

3. For the purpose of assessing beneficial use support using data collected according to the BURP protocol, DEQ should sample only in the following segments of Badger Creek: 1) the confluence of the forks to a diversion spillway approximately one mile downstream, and 2) the springs downstream of the confluence of Bull Elk Creek to the confluence of Badger Creek with the Teton River.

4. Water quality in the segment of the mainstem of Badger Creek below the diversion spillway is protected by numeric criteria when the channel contains water; turbidity during runoff should be monitored to determine whether this criterion, as an indicator of sediment, is exceeded.

5. To support beneficial uses, the water quality targets for sediment shown in Table 15 should not be exceeded at any location in Badger Creek.

Darby Creek

Darby Creek originates at an elevation of approximately 9,600 feet within the Jedediah Smith Wilderness Area on the western slope of the Teton Mountain Range. As Darby Creek flows west through the Caribou-Targhee National Forest to the Idaho-Wyoming state line, it drops more 3,000 feet in elevation over a distance of approximately 7 miles. From the state line, it drops only 400 feet in elevation as it flows another 6 miles almost due west to its confluence with the Teton River.

More than two-thirds of the 19,780 acres that comprise the Darby Creek subwatershed, as delineated in the *Teton River Basin Study* (USDA 1992), are located on the Caribou-Targhee National Forest in Wyoming. The forest boundary divides the subwatershed from east to west, and either coincides with the Wyoming-Idaho state line or is located less than one-quarter mile east of the state line. Therefore, almost all of the subwatershed east of the state line is federally owned, and all of the subwatershed west of the state line is privately owned. Forest lands are used for recreation, motorized travel, and elk and deer winter range; private lands are used for rangeland, irrigated cropland, and residential development (USDA 1992 and 1997a).

From the wilderness boundary to the forest boundary and state line, Darby Creek is classified by the Forest Service as ecological unit *2609-PIEN Cryaquolls, 2 to 8 percent slopes,* which is described by Bowerman *et al.* (1999) as follows:

> This unit is on cold, moist floodplains in the forested zone ... topography is characterized by low to high gradient (2-8 percent) floodplains in U-shaped mountain valleys ... microrelief on the floodplain is very broken and irregular ... seasonal variation in stream flow is dominated by snow melt runoff ... braided channels and confined meanders are common ... beaver dams are infrequent.

The potential natural vegetation community is Engelmann spruce/fragrant bedstraw and Engelmann spruce/field horsetail, but present vegetation also includes red osier dogwood, willow, and alder communities. Soils may extend to a depth of 60 inches and are composed of fine sandy loam, stratified silt loam to gravelly sandy loam, and stratified gravelly sandy loam to extremely cobbly coarse sand. The soils have a very slow infiltration rate when thoroughly wet due to a high shrink-swell potential and/or permanent high water table, and therefore have a high runoff potential. Flooding is frequent and lasts from April through July due to snowmelt. Susceptibility to water erosion is relatively low, as indicated by a K_w of 0.15; soil loss tolerance is moderate, as indicated by a T value of 3.

The portion of the Darby Creek subwatershed located in Idaho is an alluvial floodplain overlain by wind-deposited loess. From the state line to just west of Highway 33, the soils are level to gently sloping and well drained; west of the highway to the Teton River the soils are nearly level and poorly drained.

Flow Approximately 1 mile east of the forest boundary, the channel of Darby Creek becomes braided, and according to the USGS 7.5-minute topographic map, streamflow changes from perennial to intermittent. The braided channels diverge east of Highway 33 into three channels that pass beneath the highway. Approximately 1.5 miles west of the highway, perennial flow in each of these channels is restored through spring flows and/or subsurface flows. The northernmost channel is no longer considered a channel of Darby Creek, but is instead labeled Dick Creek on the topographic map. The middle channel becomes the mainstem of Darby Creek and receives year-round flow from a spring located at SW1/4 SE1/4 S10 T4N R45. The southernmost channel converges with the mainstem approximately 0.5 miles above the confluence of Darby Creek with the Teton River.

Discharges in Darby Creek are measured by Water District 1 at a bridge approximately 1.5 miles upstream of the Idaho-Wyoming state line. Eighteen-year average flow data indicate that high flows of approximately 180 cfs occur throughout June, rapidly decline in July to approximately 30 cfs by August 1, then continue to decline to 1 cfs by the end of November (Figure 28). Downstream of the Darby Creek gage, diverted flows are measured in the Winger, Hill, Todd, and Cannon canals in Wyoming, and the Cherry Grove canal in Idaho.

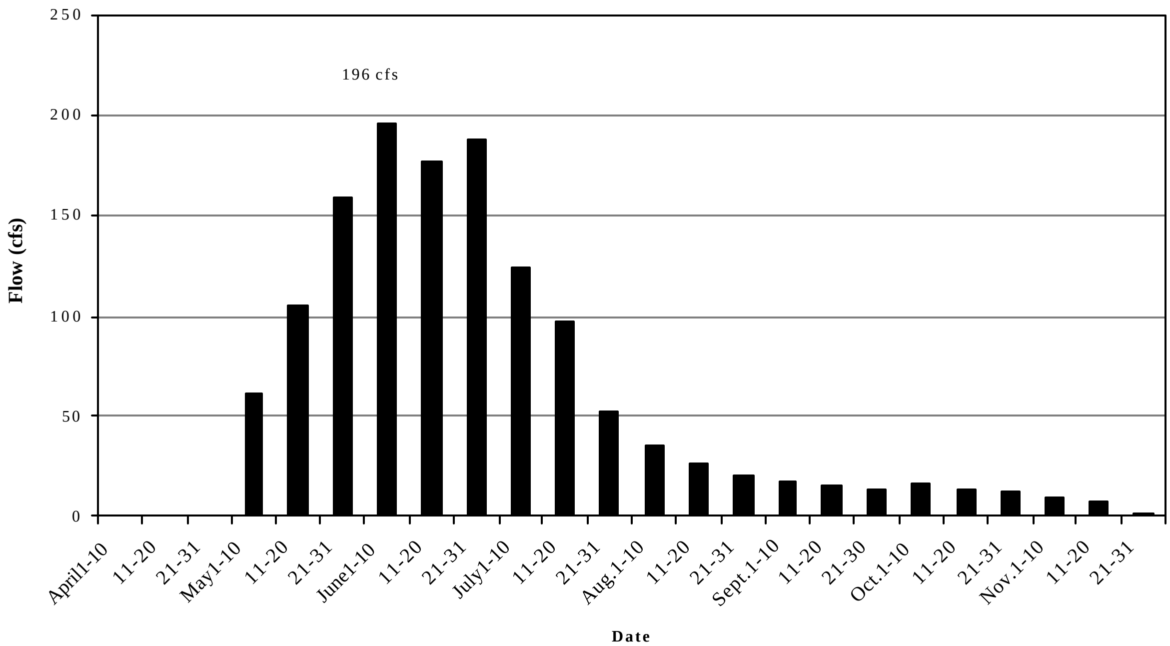

Figure 28. Eighteen-year average discharge measurements for Darby Creek

Water flows continuously in Darby Creek from the state line to Highway 33 only four-to-six weeks during the summer (Schiess personal communication). Most streamflow is typically diverted for irrigation in Wyoming, but flow diversion is not the primary reason for the intermittent nature of Darby Creek. Six to eight years ago irrigators in the lower valley called for water and upstream diversions were discontinued. Flow in the main channel extended west of Highway 33 at night but receded east of the highway during the day, and continuous flow throughout the mainstem to the Teton River did not occur (Schiess personal communication). Because the water could not reach irrigators downstream, the upstream diversions were allowed to resume. In September 1998, the Caribou-Targhee National Forest conducted a cutthroat trout inventory of Darby Creek, and notations regarding flow in the sample reach immediately upstream of the forest boundary stated that the lower section was dewatered due to irrigation diversions and low base flow.

§303(d)-Listed Segment The segment of Darby Creek shown on the 1998 §303(d) list extends from Highway 33 to the Teton River, a distance of slightly more than 3 miles (Figure 29). The pollutants of concern are sediment and flow alteration. The results of BURP sampling conducted in 1995 indicated that the beneficial use of cold water aquatic life was supported in Darby Creek at the Idaho-Wyoming state line (MBI of 4.84 at site 95-B053), but was not supported in the mainstem of Darby Creek immediately downstream of Highway 33 (MBI of 1.41 at site 95-B007). A third site, just upstream of the confluence of Darby Creek with the Teton River, was visited in 1995 could not be sampled because the stream reach did not contain riffles. The low MBI score obtained at the site downstream of Highway 33 was responsible for Darby Creek remaining on the 1998 §303(d) list. In 1997, an attempt was made to resample this site, but records show that the site sampled in 1997 was in the channel that becomes Dick Creek, not in the mainstem of Darby Creek (Figure 30).

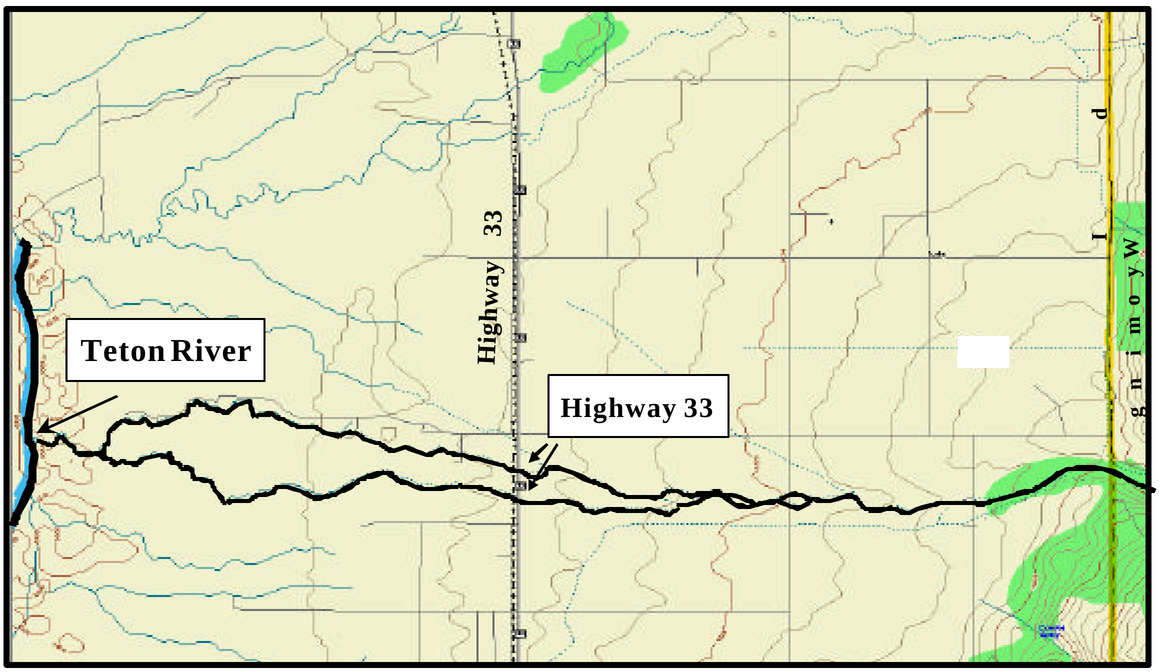

Figure 29. Boundaries of the segment of Darby Creek which appeared on Idaho's 1998 section 303(d) list.

Because a downstream site on Darby Creek was not sampled in 1995, sampling of the lower reach was conducted again in 1997 (97-L073) and 1998 (98-E003) on the mainstem upstream of its confluence with the southern channel (Figure 30). The MBI score for the 1997 sample (3.36) fell within the "needs verification" range, and combined with the low habitat index score (59), the site was assessed as "not full support" for cold water aquatic life. The same area of the stream was sampled again in 1998, and while the MBI score (4.55) indicated "full support" for cold water aquatic life, the habitat index score (63) remained low. Some of the factors that contributed to the poor habitat index scores were highly embedded substrate (greater than 75%), high percentages of surface fines (86% and 96%), and less than 30% of potential plant biomass remaining along streambanks.

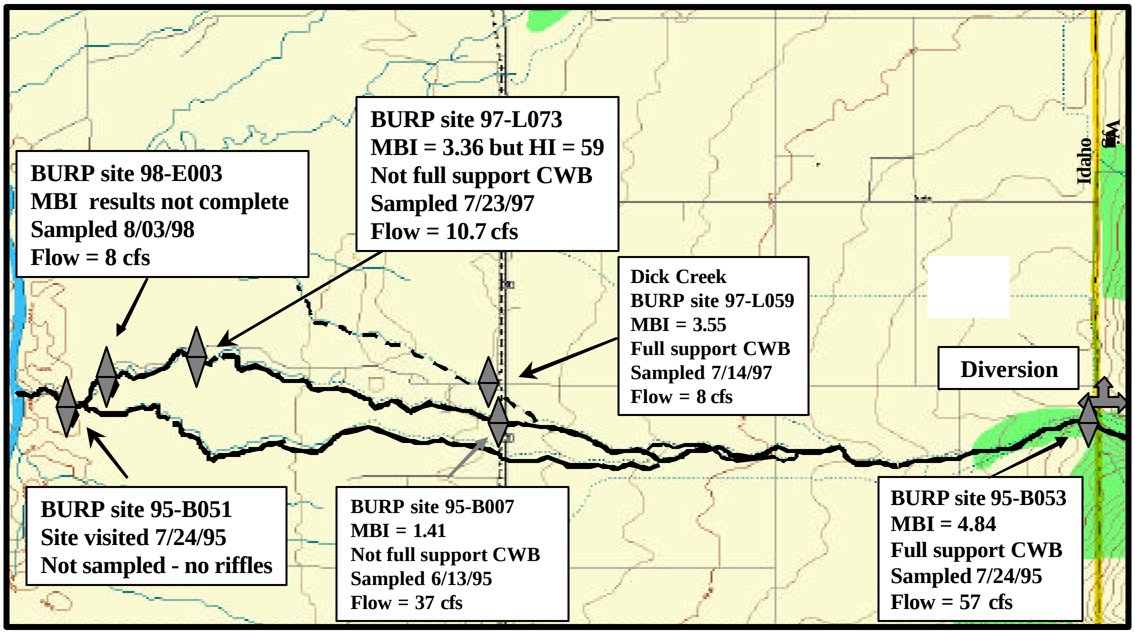

Figure 30. Data collection sites on Darby Creek

Resource Problems Identified by the USDA and TSCD The *Teton River Basin Study* (USDA 1992) estimated that the total sediment yield from agricultural lands in the Darby Creek subwatershed was 2,601 tons/year. Of that amount, 65% originated from streambanks and 35% originated from land use. Implementing structural practices, identified as Alternative 2 in the *Teton River Basin Study* (USDA 1992), was expected to reduce the total sediment yield to 1,581 tons/year by reducing streambank erosion by 52% and land use erosion by 16%. The majority of the agricultural land located in the subwatershed occurs within treatment units 12 or 10/11, with small portions occurring in treatment units 4, 8, and 9. The causes of resource problems identified for treatment unit 12 were overgrazing of uplands, season of use by livestock, roads, overland runoff/surface and gully erosion, and urbanization/home building. The causes of resource problems identified for treatment unit 10/11 were overgrazing in the riparian area; removing stream-side shrubs, trees, and other vegetation; straightening sections of stream channel; improper culvert placement; flooding; stream evolution; reduced sub-water flows; poorly controlled flood irrigation systems; and erosion of uplands (USDA 1992).

Water Quality Data The results of water quality sampling conducted by DEQ in 2000 did not indicate high concentrations of suspended sediment in Darby Creek at the location and times sampled (Appendix I). Samples were collected approximately 300 feet west of Highway 33 on the mainstem of Darby Creek, in an area that corresponded to BURP site 95-B007 (Figure 30). The maximum concentration of TSS (3.1 mg/L) was far below the designated target of 80 mg/L, and maximum turbidity (8.4 NTU) was far below the criterion specified in Idaho's water quality standards (i.e., not greater than 50 NTU above background). Turbidity values measured in June 1999 showed a small increase from the forest boundary (4 NTU) to the site below the highway (11 NTU), but again, these values were far below the water quality criterion.

Evidence of excessive sediment deposition in Darby Creek was provided by the results of subsurface sediment analyses performed at the sampling site downstream of Highway 33. Approximately 12% of particles were less than 0.85 mm in diameter and 37% were less than 6.3 mm in diameter. These values exceed the targets for subsurface fine sediment shown in Table 15 by 2% for particles less than 0.85 mm and by 12% for particles less than 6.3 mm.

The only other analytical data found for Darby Creek were reported in a letter from DEQ to the Caribou-Targhee National Forest for water samples collected in 1980. The samples are described in the letter as "Darby Creek above Spring" and "Darby Spring," though exact sampling locations are not specified. Despite the lack of information regarding sampling locations, the analytical results for nutrients and suspended solids are shown in Table 26 because these data may be useful for evaluating long-term water quality trends if the location of the sampling sites can be confirmed. Concentrations of nutrients measured in Darby Spring water were generally lower than in water taken from Darby Creek above the spring, with one notable exception. The concentration of $NO_2 + NO_3$ was higher in the spring water (0.147 mg/L) than in the surface water (0.098 mg/L), though it is impossible to evaluate the significance of these results on the basis of only one sample. Nitrate concentrations measured in Darby Creek below Highway 33 in 2000 were similar to the values measured in 1980, ranging from below detection level to 0.09 mg/L (Appendix I).

Table 26. Water quality data for Darby Creek reported in a letter dated October 6, 1980, from the Idaho Division of Environment to the Targhee National Forest.

Water Quality Parameter	Darby Creek above Spring	Darby Spring
Ammonia (mg/L as N)	0.014	0.009
$NO_2 + NO_3$ (mg/L as N)	0.098	0.147
Total phosphorus (mg/L as P)	0.05	< 0.01
Orthophosphate (mg/L as P)	0.003	< 0.01
Suspended solids (mg/L)	< 2	< 2

Fisheries Fisheries data for Darby Creek were recently collected by the Caribou-Targhee National Forest and DEQ, and fisheries habitat was assessed on the forest in 1991 (Raleigh Consultants 1991). Cutthroat trout were present throughout the stream reaches sampled on the forest, and ranged in size from 50 to 300 mm. One brook trout and one rainbow trout were also captured during the forest survey. Darby Creek was electrofished below the forest boundary by DEQ in 1996 at BURP site 95-B052. Most water had been diverted from the stream channel, but three year classes of cutthroat trout were collected, mostly from a large pool. Based on these data, the segment of Darby Creek from the forest boundary to Highway 33 was assessed as fully supporting salmonid spawning. Site 97-L073 was electrofished as a representative site for the stream segment from Highway 33 to the Teton River, and only two brook trout and two sculpin were collected. These results did not indicate that salmonid spawning was supported, but local residents report that they have observed brook trout spawning in Darby Creek as far upstream as the spring west of Highway 33.

Discussion Darby Creek consists of two hydrologically distinct segments. The source of water in the upper segment is snowmelt runoff; the source of water in the lower segment is upwelling subsurface water and a spring located approximately 1 mile west of Highway 33. In late May, June, and early July, runoff is usually sufficient to provide flow from the headwaters of Darby Creek to the Teton River. Otherwise, the channel in the vicinity of Highway 33 is dry. In 1999, the Henry's Fork Watershed Council Water Quality Subcommittee recommended that the boundary separating Darby Creek into two segments be changed from Highway 33 to the spring west of the highway. From the spring upstream to approximately one mile east of the forest boundary, the flow in Darby Creek is intermittent and heavily diverted during the irrigation season. Downstream of the spring, flow in Darby Creek appears to be relatively constant though discharge has not been measured. When DEQ assessed Darby Creek for the 1998 §303(d) list, the assessment of "not full support" for cold water aquatic life was based on sampling conducted at a site downstream of Highway 33 that is apparently dry most of the year. Based on flow, this site is more representative of Darby Creek upstream of Highway 33 than it is of Darby Creek downstream of Highway 33. Similarly, the assessment of the segment upstream of Highway 33 as "full support" for both cold water aquatic life and salmonid spawning was based on sampling conducted at a site just below the forest boundary and above a major diversion. This site is probably more representative of Darby Creek upstream of the forest boundary than it is of Darby Creek downstream of the forest boundary.

Conclusions Conclusions regarding the water quality status of Darby Creek are listed below.

1. Discharge in the segment of Darby Creek that appeared on the 1998 §303(d) list is intermittent from Highway 33 to the spring west of Highway 33, but the segment downstream of the spring is sufficient to support aquatic life uses at all times. Although the beneficial uses of this segment of Darby Creek have not yet been assessed, the MBI scores for samples collected in 1997 and 1998 are "fair" to "very good" while HI scores indicate impairment due to sediment deposition. Development of a total maximum daily load for sediment is appropriate.

2. Discharge in the segment of Darby Creek from the Idaho-Wyoming state line to the spring west of Highway 33 is intermittent. The biological indices used by DEQ to assess the beneficial uses of cold water aquatic life and salmonid spawning were developed using data collected for aquatic insect or fish communities sampled in perennially flowing reference streams. Similar species diversity and other community measures cannot be expected to occur in channels that periodically become dry. Therefore, it is not appropriate for DEQ to use data collected using the BURP protocol to assess beneficial use support in Darby Creek upstream of the spring west of Highway 33.

3. For the purpose of assessing beneficial use support using data collected according to the BURP protocol, DEQ should sample only in the segment of Darby Creek from the spring west of Highway 33 to the confluence of Darby Creek with the Teton River.

4. Water quality in the segment of Darby Creek between the diversion near the Idaho-Wyoming state line and the spring west of Highway 33 is protected by numeric criteria when the channel contains water, and turbidity during runoff should be monitored to determine whether this criterion, as an indicator of sediment, is exceeded.

5. To support beneficial uses, the water quality targets for sediment shown in Table 15 should not be exceeded at any location in Darby Creek.

6. While Darby Creek is impaired due to flow alteration, a TMDL for flow will not be developed. The EPA does not believe that flow (or lack of flow) is a pollutant as defined by section 502(6) of the CWA. DEQ is not required to establish TMDLs for waterbodies impaired by pollution but not pollutants, so it is the policy of the state of Idaho to not develop TMDLs for flow alteration.

Fox Creek

Fox Creek originates at an elevation of almost 9,500 feet in the Jedediah Smith Wilderness Area on the western slope of the Teton Mountain Range. As it flows west toward the Caribou-Targhee National Forest boundary and Idaho-Wyoming state line, it drops approximately 2,800 feet in elevation over a distance of 7 miles. From the state line, it flows north and west less than 2 miles before it branches into several intermittent channels. West of Highway 33, perennial flow is restored by springs, and Fox Creek flows an additional 2 miles before reaching the Teton River.

Slightly less than half of the 15,429 acres that comprise the Fox Creek subwatershed, as delineated in the *Teton River Basin Study* (USDA 1992), are located on the Caribou-Targhee National Forest in Wyoming. The forest boundary divides the subwatershed from east to west, and coincides with the Wyoming-Idaho state line. Approximately 1,500 acres west of the state line are managed by the BLM, but all other land in Idaho is privately owned. Forest lands are used for recreation, motorized travel, and elk and deer winter range; private lands are used for rangeland, irrigated cropland, forest, and residential development (USDA 1992 and 1997a).

From the wilderness boundary to the forest boundary and state line, Fox Creek is classified by the Forest Service as ecological unit “2609-PIEN Cryaquolls, 2 to 8 percent slopes,” which is described by Bowerman *et al.* (1999) below.

> This unit is on cold, moist floodplains in the forested zone ... topography is characterized by low to high gradient (2-8 percent) floodplains in U-shaped mountain valleys ... microrelief on the floodplain is very broken and irregular ... seasonal variation in stream flow is dominated by snow melt runoff ... braided channels and confined meanders are common ... beaver dams are infrequent.

The potential natural vegetation community is Engelmann’s spruce/fragrant bedstraw and Engelmann’s spruce/field horsetail, but present vegetation also includes red osier dogwood, willow, and alder communities. Soils may extend to a depth of 60 inches and are composed of fine sandy loam, stratified silt loam to gravelly sandy loam, and stratified gravelly sandy loam to extremely cobbly coarse sand. The soils have a very slow infiltration rate when thoroughly wet due to a high shrink-swell potential and/or permanent high water table, and therefore have a high runoff potential. Flooding is frequent and lasts from April through July due to snowmelt. Susceptibility to water erosion is relatively low, as indicated by a K_w of 0.15; soil loss tolerance is moderate, as indicated by a T value of 3.

The portion of the Fox Creek subwatershed located in Idaho is an alluvial floodplain overlain by wind-deposited loess. From the state line to west of Highway 33, the soils are level to gently sloping and well drained; from 0.5 miles to 1.5 miles west of the highway to the Teton River, the soils are nearly level and poorly drained.

Flow According to the USGS 7.5-minute topographic map, Fox Creek branches into two channels approximately 1.6 miles west of the forest boundary and flow changes from perennial to intermittent. These channels branch again, and four intermittent channels are shown on the topographic map passing beneath Highway 33. On some 1:100,000-scale maps and GIS coverages, Fox Creek is incorrectly shown to terminate west of the highway. But on the topographic map at 1:24,000-scale, one of the channels splits into two branches immediately west of the highway then rejoins after perennial flow is restored in each branch by springs located approximately 1.5 miles west of the highway. This channel has apparently been straightened and flows parallel to a county road until it empties into a channel that arises from springs west of the highway. The second channel then converges with another channel that arises west of the highway at Tonk’s Spring. At this point, the Fox Creek channel is well defined, and it continues to receive discharge from other small, spring-fed channels as it flows toward the Teton River. Near its confluence with the Teton River, the channel of Fox Creek becomes wide and shallow. Downstream of the point at which Fox Creek joins the Teton River, the channel width of the river appears to double.

In the late 1970s, a pipeline was installed on Fox Creek less than 0.5 miles below the forest boundary in the vicinity of the North Fox Creek Canal diversion. The pipeline provides water for a sprinkler irrigation system that serves much of the Fox Creek subwatershed, and the North Fox Creek Canal is no longer used to provide water for flood irrigation. Water District 1 currently reports discharge at five stream or diversion locations: 1) the pipeline diversion, 2) a gage located on Fox Creek downstream of the pipeline and immediately upstream of the Center Canal diversion, 3) the Center Canal, 4) the Parrish Canal, and 5) Fox Creek (a location that is apparently upstream from all diversions). The eighteen-year flow averages shown in Figure 31 were calculated using values reported for Fox Creek.

Discharge from Fox Creek is low relative to other Teton River tributaries that originate in the Teton Mountains. The maximum average discharge for Fox Creek (87 cfs) is less than half the maximum average for Darby Creek (196 cfs) or North Leigh Creek (216 cfs), and less than one-third the maximum average for South Leigh Creek (272 cfs). In August, more than half of the discharge in Fox Creek is diverted to the pipeline and the remainder is diverted to the Center and Parrish Canals. Like Darby Creek, Fox Creek appears to flow continuously from its headwaters to the Teton River only for a few weeks in June and July when snowmelt at higher elevations in the subwatershed produce the highest stream discharges.

Fox Creek near the Teton River marks the lower boundary of Foster Slough, a large wetland complex that extends north to Darby Creek. Foster Slough is also shown on the USGS 7.5-minute topographic map as a distinct channel that flows into the Teton River above Darby Creek. The *Teton River Basin Study* (USDA 1992) shows Foster Slough as a distinct 3,548-acre subwatershed, though the topographic map shows channels connecting Fox Creek and the Foster Slough channel.

§303(d)-Listed Segment The segment of Fox Creek shown on the 1998 §303(d) list extends from the Idaho-Wyoming state line to the Teton River (Figure 32). The pollutants of concern are sediment, temperature, and flow alteration.

The results of BURP sampling conducted in 1995 indicated that the beneficial use of cold water aquatic life was supported in Fox Creek approximately 0.6 mile below the Idaho-Wyoming state line (MBI of 5.07 at site 95-A094), but was not supported 0.5 mile downstream of Highway 33 (MBI of 2.99 at site 95-B050) (Figure 32).

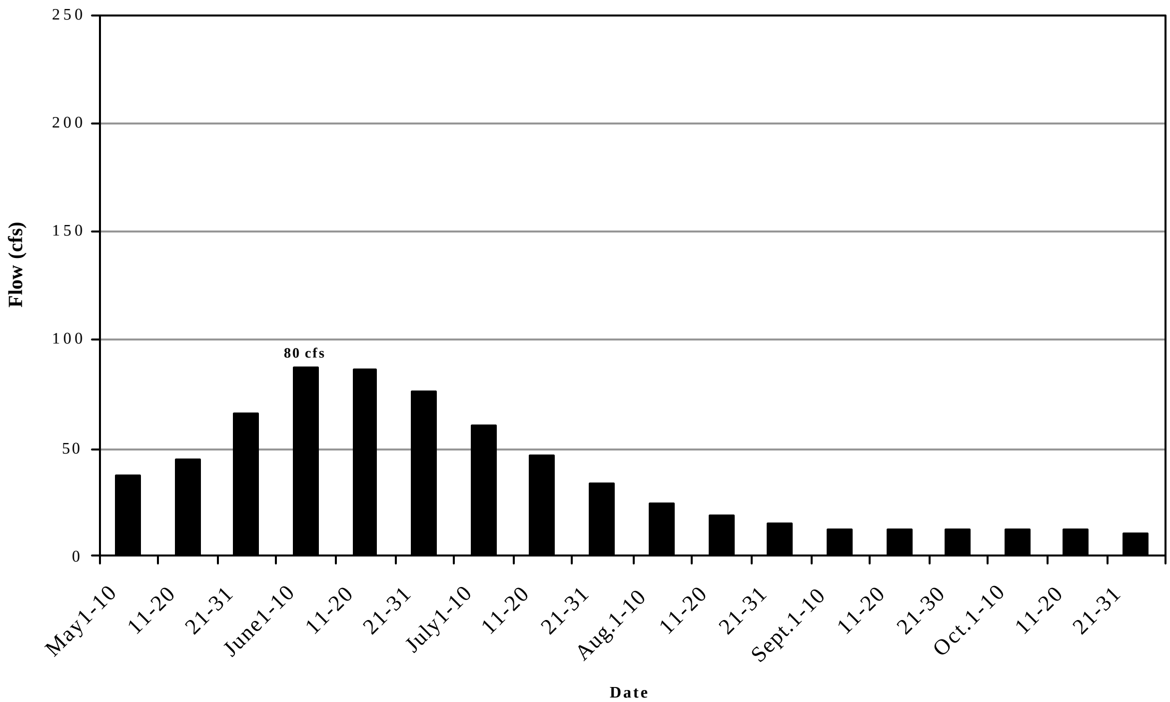

Figure 31. Eighteen-year average discharge measurements for Fox Creek.

The BURP sampling sites were not directly comparable because the upper site was located in the Middle Rockies ecoregion in Douglas-fir forest, while the lower site was located in the Snake River Plain ecoregion where grasses and cottonwood trees dominated the riparian vegetation. The HI score for the upper site (86) exceeded the value considered to support cold water aquatic life in the Middle Rockies ecoregion (81), but the HI score for the lower site (60) was far below the value considered to support cold water aquatic life in the Snake River Plain ecoregion (89). Factors that contributed to the poor HI score at the lower site included banks that were less than 75% stable, almost 50% substrate embeddedness, and 61% surface fines less than 6 mm in diameter.

The BURP site sampled downstream of the highway (site 95-B050) would probably have been dry in an average-flow year. According to 18-year flow data, average maximum discharge (87 cfs) occurs in Fox Creek in the first 10 days of June. In 1995, the maximum discharge that was measured (116 cfs) occurred on July 11, approximately two weeks before the BURP site was sampled.

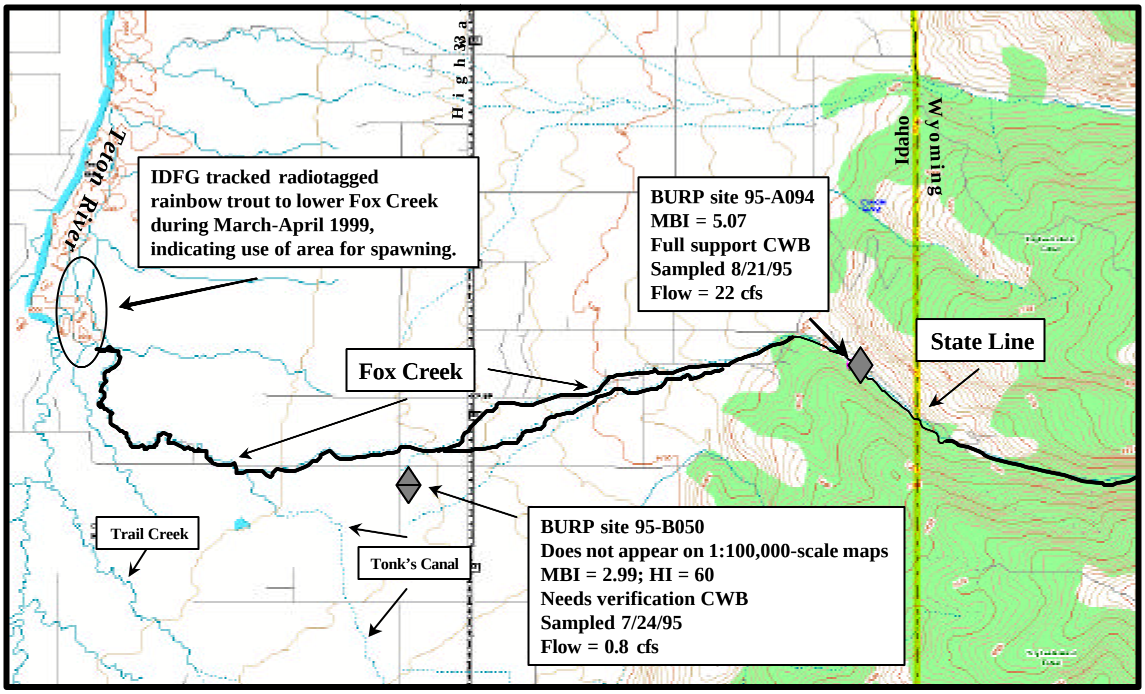

Figure 32. Data collection sites on Fox Creek and boundaries of the segment of Fox Creek identified on Idaho's 1996 section 303(d) list of water quality-impaired water bodies. Pollutants of concern included sediment, flow alteration, and temperature modification.

Resource Problems Identified by the USDA and TSCD The *Teton River Basin Study* (USDA 1992) estimated that the total sediment yield from agricultural lands in the Fox Creek subwatershed was 3,336 tons/year. Of that amount, 57% originated from streambanks and 43% originated from land use. Implementing structural practices, identified as Alternative 2 in the *Teton River Basin Study* (USDA 1992), was expected to reduce total sediment yield to 2,040 tons/year by reducing streambank erosion by 43% and land use erosion by 33%. The majority of the agricultural land located in the subwatershed occurs within treatment units 9, 10/11, and 12, with a small portion occurring in treatment units 2 and 6. The sources of resource problems identified for treatment unit 9 were sheet, rill, gully, wind and irrigation-induced erosion caused by pulverized soil surface conditions following potato harvest, spring barley seedbeds that lack adequate surface residues, fall disking, over-tilled mechanical summer fallow, up and downhill potato planting, soil compaction, and over application of irrigation water. The causes of resource problems identified for treatment unit 10/11 were overgrazing in the riparian area; removing stream-side shrubs, trees, and other vegetation; straightening sections of stream channel; improper culvert placement; flooding; stream evolution; reduced sub-water flows; poorly controlled flood irrigation systems; and erosion of uplands. The causes of resource problems identified for treatment unit 12 were overgrazing of uplands, season of use by livestock, roads, overland runoff/surface and gully erosion, and urbanization/home building (USDA 1992).

Water Quality Data With the exception of temperature data collected by IDFG beginning in 1996, there were no water quality data available for Fox Creek when this assessment started. In 1998 and 1999, researchers at Idaho State University measured high concentrations of nitrate (greater than 0.79 mg/L) in water samples collected from Fox Creek near its confluence with the Teton River (Thomas *et al.* 1999, Minshall 2000). Because of these results, DEQ performed additional sampling at this site and an upstream site in 2000. Unlike sampling conducted on other streams by DEQ in 2000, the sampling sites on Fox Creek did not correspond to BURP sites sampled in 1995. The upper sampling site in 2000 was located on the Caribou-Targhee National Forest where the road ends; the lower sampling site was located upstream of the confluence of Fox Creek with the Teton River.

The results of water quality sampling conducted by DEQ in 2000 did not indicate high concentrations of suspended sediment in Fox Creek at the locations and times sampled, but they did confirm high concentrations of nitrate at the downstream site (Appendix I). The maximum concentration of TSS (5.1 mg/L) was far below the designated target of 80 mg/L, and maximum turbidity (3.1 NTU) was far below the criterion specified in Idaho's water quality standards (i.e., not greater than 50 NTU above background). Nitrate concentrations at the upper sampling site ranged from 0.07 to 1.1 mg/L whereas concentrations at the lower sampling site ranged from 0.87 to 1.09 mg/L (Appendix I). These concentrations were approximately three times greater than the target of 0.3 mg/L.

The discharge data collected for these sites provide additional evidence that the hydrologic regimes of the upper and lower segments of Fox Creek are controlled by different factors. Discharge measured at the lower site was 57 cfs on June 14, 2000, and 56 cfs on August 21, 2000, indicating a consistent source of water such as spring flow. At the upper site, water velocity precluded discharge measurements during the first three site visits, but discharge was only 12 cfs during the last visit on August 21. Because discharge was much less in upper Fox Creek (12 cfs) than in lower Fox Creek (56 cfs), the source of flow in the lower creek could not have been upstream surface water. However, surface flows in upper Fox Creek are believed to contribute to flows in lower Fox Creek indirectly by replenishing ground water flows that recharge springs.

Subsurface sediment was analyzed in 2000 at the lower Fox Creek site. Ninety-five percent of particles were less than 0.85 mm in diameter and 100% were less than 6.3 mm in diameter. These values exceed the targets for subsurface fine sediment shown in Table 15 by 85% for particles less than 0.85 mm and by 73% for particles less than 6.3 mm. However, these targets may be unachievable for lower Fox Creek because it is a spring-fed, low-gradient, depositional stream channel that originates in a wet meadow in silty clay loam soil.

According to data collected by IDFG in 1996, 1997 and 1998 (Schrader 2000a) and by DEQ in 2000, temperatures in lower Fox Creek do not exceed Idaho's criteria for cold water aquatic life (i.e., 22^{o}C or less with a maximum daily average no greater than 19^{o}C) (Figures 33-36). However, the 13^{o}C temperature maximum for salmonid spawning was exceeded in all years, usually from the beginning of May or June through the end of October (Figures 33-36). A radiotagged rainbow trout hybrid was found spawning in lower Fox Creek during the last two weeks of March 1999, indicating that this segment is used by early spring spawners (Schrader 2000a).

Because the discharge in lower Fox Creek originates from springs, water temperatures remain fairly constant throughout the year. In fact, Fox Creek and other spring-fed tributaries of the Teton Valley section of the Teton River are considered important wintering areas for fish because they serve as thermal refuges (USDA 1992). In streams such as the upper portion of Badger Creek, where discharge is controlled by snowmelt, water temperatures tend to increase as air temperatures increase (Figure 27). But as shown in Figures 33 through 36, water temperatures in a spring-fed stream increase in the spring and decrease in the fall in response to air temperatures, but remain relatively constant throughout the summer. In the four years during which temperature data were collected, maximum daily water temperatures ranging between 17 ^{o}C and 20 ^{o}C occurred between mid-July and mid-August when average daily air temperatures reach their maximum in Teton Valley (Table 1). However, these maximum temperatures were also reached in late April of 1998 (Figure 35) and mid-May of 2000, indicating that something other than air temperature was influencing water temperature. The most dramatic changes in water temperature in lower Fox Creek apparently coincided with periods of extreme runoff when snowmelt actually reached the area where the thermographs were located. For example, the maximum discharge measured in Fox Creek in 1998 upstream of diversions near the forest boundary was 112 cfs on June 30. This corresponded to a drop in maximum daily temperature in lower Fox Creek from 14 ^{o}C to 9 ^{o}C (Figure 35).

Based on available data, it is not possible to conclude that fish have completed spawning in lower Fox Creek before temperature criteria for salmonid spawning are exceeded. Salmonid spawning probably occurs in Fox Creek no later than the end of April. Salmonid spawning temperature criteria were not exceeded until the end of May in 1996 (Figure 33), the beginning of May in 1997 (Figure 34), and the middle of April in 1998 (Figure 35). However, because maximum average air temperatures are approximately equivalent to water temperatures at this time of year, water temperatures in lower Fox Creek appear to be determined at its source, which is a spring. Before concluding that a load allocation for temperature is appropriate, the period of salmonid spawning in lower Fox Creek must be better defined and additional temperature data must be collected closer to the spring source to determine the natural temperature regime of this segment of the stream.

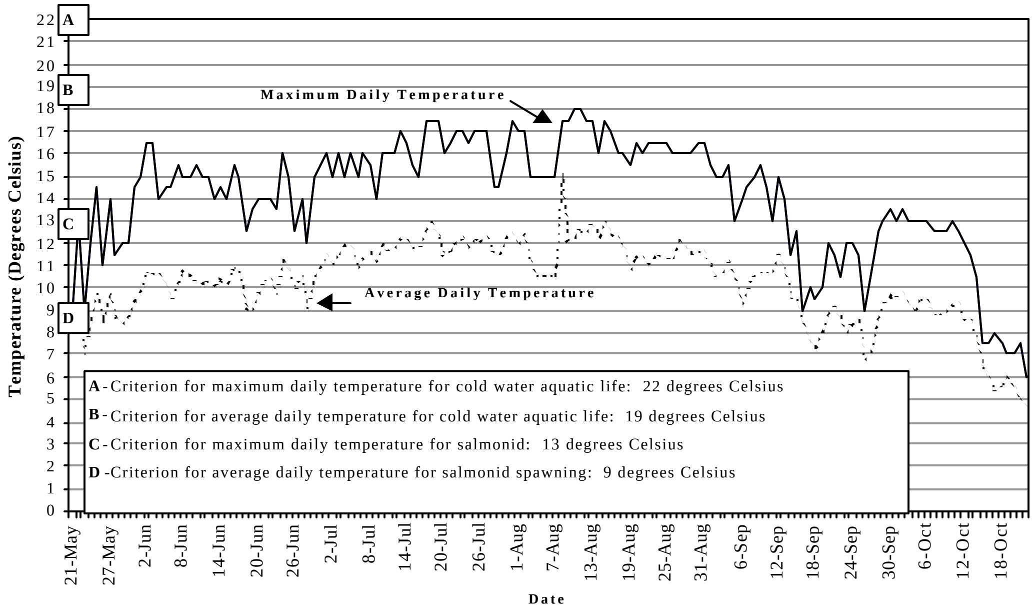

Figure 33. Fox Creek water temperatures from March 20 through October 21, 1996 (Schrader 2000).

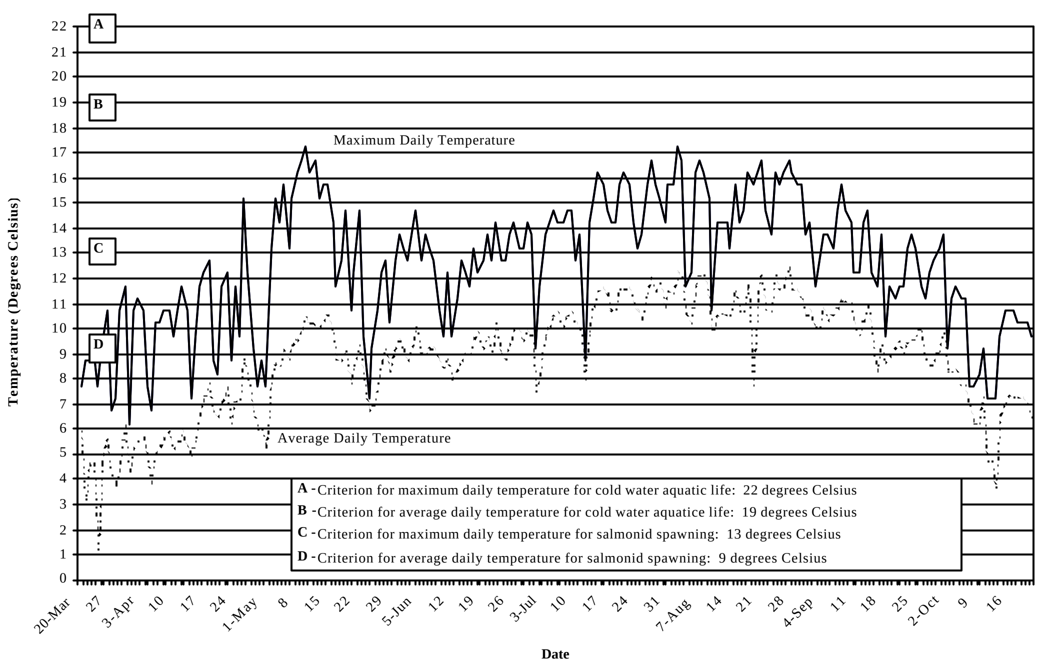

Figure 34. Fox Creek water temperatures from March 20 through October 21, 1997 (Schrader 2000).

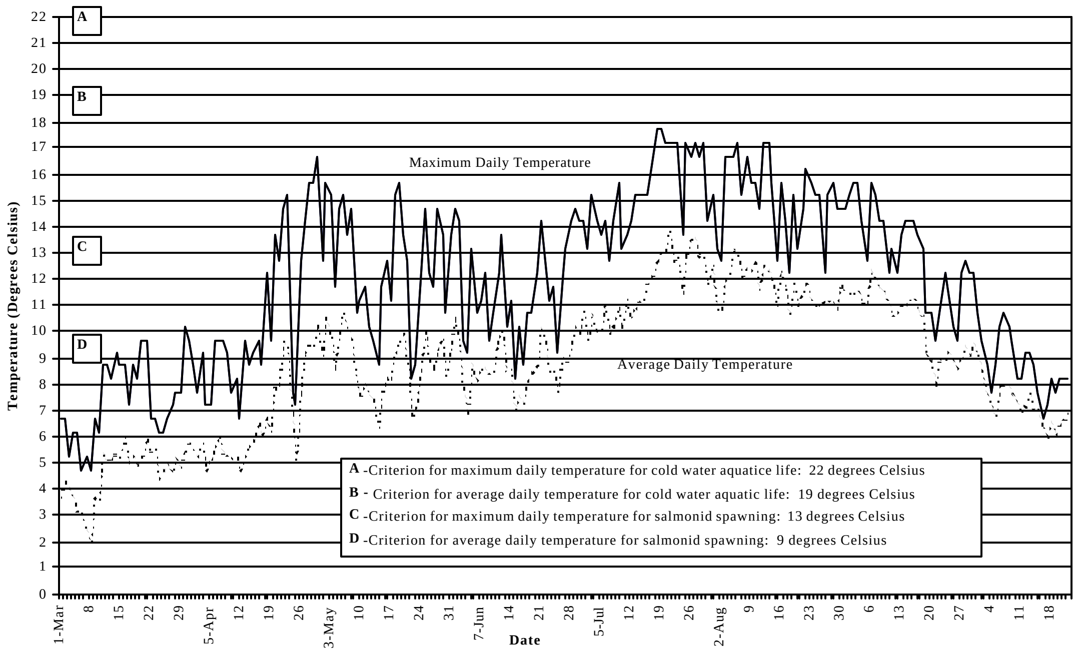

Figure 35. Fox Creek water temperatures from March 1 through October 21, 1998 (Schrader 2000)

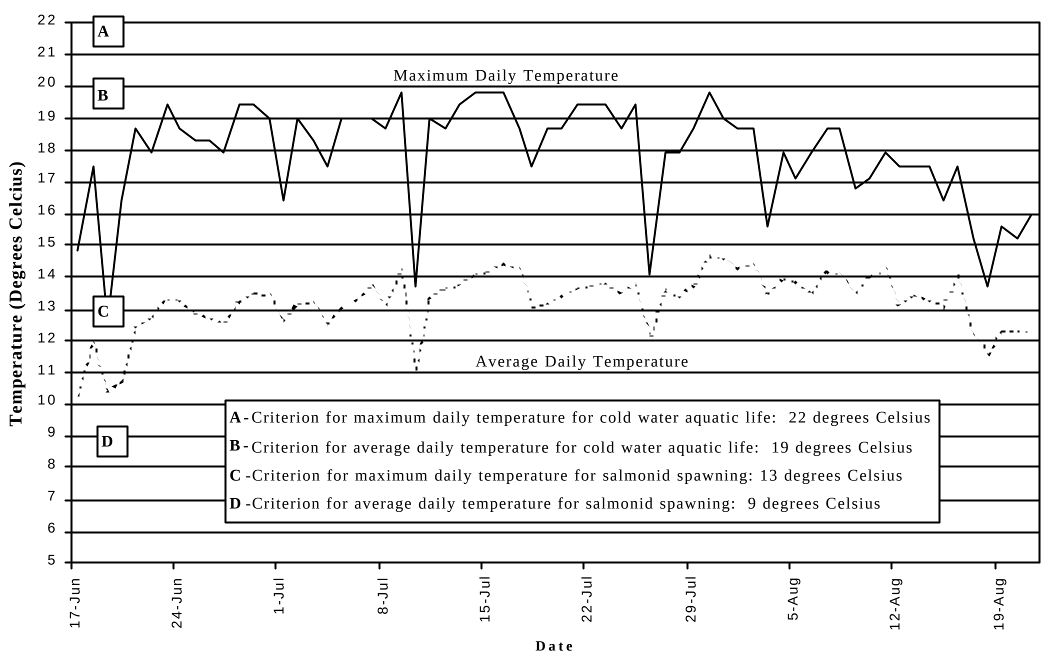

Figure 36. Fox Creek temperatures from June18 through August 21, 2000.

Fisheries Fisheries data for Fox Creek were recently collected by the Caribou-Targhee National Forest and DEQ, and fisheries habitat was assessed on the forest in 1980. In August 1998, Forest biologists surveyed Fox Creek from the forest boundary to the wilderness boundary for cutthroat trout. None were collected, but brook trout were present in every stream unit electrofished. Upper Fox Creek below the forest boundary was electrofished by DEQ in 1996 at BURP site 95-A094, and three year classes of brook trout, including juveniles, were collected. Based on these data, Fox Creek was assessed as fully supporting salmonid spawning.

Data collected by IDFG indicates that lower Fox Creek is used by fish in the Teton River for spawning in early spring. A radiotagged rainbow trout hybrid was found spawning in lower Fox Creek during the last two weeks of March 1999 (Schrader 2000a). Lower Fox Creek immediately west of the Highway 33 was electrofished by DEQ in July 1997 at BURP site 95-B050. No fish were collected, but because this site is upstream of springs that restore perennial flow to Fox Creek, it was probably not an appropriate location for sampling. The stream channel contained water at this location in 1997 because relatively high runoff persisted into late July.

An 8-foot-high concrete dam extends across the width of Fox Creek just above the forest boundary in the vicinity of a privately owned limestone quarry. This dam was apparently built to create a settling pond for the quarry, and in 1980 was filled in to a depth of 6 or 7 feet. In 1980, the fisheries biologist for the Caribou-Targhee National Forest reported that the dam blocked fish passage, though the presence of brook trout below the dam in 1996 indicates that it blocks upstream passage only.

Discussion Like Darby Creek, Fox Creek consists of two hydrologically distinct segments. The source of water in the upper segment is snowmelt runoff; the source of water in the lower segment is upwelling subsurface water and springs located approximately one mile west of Highway 33. For a few weeks during the summer, runoff may be sufficient to provide flow from the headwaters of Fox Creek to the Teton River. Otherwise, the channel in the vicinity of Highway 33 is dry. In 1999, the Henry's Fork Watershed Council Water Quality Subcommittee recommended separating Fox Creek into three segments (Appendix D). The first segment extends from the forest boundary to the North Fox Creek Canal, the second extends from the North Fox Creek Canal to the location of springs that recharge lower Fox Creek, and the third extends from the springs to the Teton River. The first and third segments contain water on a perennial basis; the second segment contains water on an intermittent basis. When DEQ assessed Fox Creek for the 1998 § 303(d) list, the assessment of "not full support" for cold water aquatic life was based on sampling conducted at a site downstream of Highway 33 that is probably dry most of the year. Additional data indicate that the beneficial uses of cold water aquatic life and salmonid spawning are supported in upper Fox Creek upstream of the pipeline and lower Fox Creek downstream of the springs.

Conclusions Conclusions regarding the water quality status of Fox Creek are listed below.

1. Discharge in the segment of Fox Creek that appeared on the 1998 §303(d) list is intermittent from North Fox Creek Canal to the springs west of Highway 33. However, the segments from the forest boundary to North Fox Creek Canal and from the springs west of Highway 33 to the confluence of Fox Creek with the Teton River are sufficient to support aquatic life uses year-round.

2. Discharge in the segment of Fox Creek assessed as not supporting cold water aquatic life is intermittent. The biological indices used by DEQ to assess the beneficial uses of cold water aquatic life and salmonid spawning were developed using data collected for aquatic insect or fish communities sampled in perennially flowing reference streams. Similar species diversity and other community measures cannot be expected to occur in channels that periodically become dry. Therefore, it was not appropriate for DEQ to use data collected using the BURP protocol to assess beneficial use support at this site.

3. For the purpose of assessing beneficial use support using data collected according to the BURP protocol, DEQ should sample only in two segments of Fox Creek: from the forest boundary (and Idaho-Wyoming state line) to the North Fox Creek Canal and the springs west of Highway 33 to the confluence of Fox Creek with the Teton River.

4. Water quality in the intermittent segment of Fox Creek is protected by numeric criteria when the channel contains water, and turbidity during runoff should be monitored to determine whether this criterion, as an indicator of sediment, is exceeded.

5. To support beneficial uses, the water quality targets for sediment shown in Table 15 should not be exceeded at any location in Fox Creek.

6. Development of a TMDL for sediment is appropriate based on subsurface sediment data collected in 2000 and information collected by the TSCD in the early 1990s (USDA 1992). However, because of the low-gradient, depositional character of lower Fox Creek, the subsurface sediment targets of 10% for particles less than 0.85 mm and 27% for particles less than 6.3 mm may be too low and may need to be adjusted for TMDL implementation.

7. The temperature TMDL for Fox Creek has been rescheduled for the end of 2002.

8. While Fox Creek is impaired due to flow alteration, a TMDL for flow will not be developed. The EPA does not believe that flow (or lack of flow) is a pollutant as defined by section 502(6) of the CWA. DEQ is not required to establish TMDLs for waterbodies impaired by pollution but not pollutants, so it is the policy of the state of Idaho to not develop TMDLs for flow alteration.